Dolores Selga[1])

The ecology of three communities of soil Collembola

INTRODUCTION

Biocenotic studies of soil Collembola populations in three forest zones of Spain have enabled us to show clearly the parallelism which exists between the distribution of the species we have found and the climatic factors and phytosociology. We shall consider the ecological position only of those species which are considered to be fundamental components of the biocenosis.

LOCALITIES STUDIED

a) Parque Nacional de Aigües Tortes (Spanish Central Pyrenees). Granitic subsoil. Situated at between 1600 and 2428 m above sea-level. Vegetation of *Fagus sylvatica, Abies alba, Pinus uncinata, Rhododendron ferrugineum* and subalpine meadows of *Selineto- Nardetum.* Seventy four Collembola species were found.

b) Sierra Guadarrama (Central mountains). Granitic subsoil. Situated at between 900 and 2400 m above sea level. Vegetation of *Quercus ilicis, Pinus pinaster, Cistus laurifolius, Quercus pyrenaica, Pinus sylvestris, Junipereto-Saratamnietum* and meadows. One hundred and thirteen Collembola species were found.

c) Tibidabo forest (Barcelona). 532 m above sea-level. Subsoil metamorphic rocks. Vegetation of sclerophyte Mediterranean Forest: *Quercetum Ilicis- Gallaprovincialis, Pinus halepensis.* Ninety seven Collembola species were found.

The study was based on more than 100 samples, collected in different years and months from each Collembola community.

METHODS

The unit for qualitative and quantitative analyses was a sample of 400 to 450 ccm. For the study of the biocenotic composition we took the com-

[1]) Instituto de Edafologia y Biologia Vegetal (CSIC) Serrano 113, Madrid

plete list of species which made up the community. The frequency abundance, vicariant habit and cenotic affinity of the species enabled us to obtain an idea of the hierarchy of each biocenosis and to compare them. The concepts and methods used were those of other specialists (Gisin, 1947; Cassagnau, 1961), particularly those of Cassagnau which are especially well developed.

The choice of the fundamental species of each of the communities was based on the most frequent species (about 50 % of total frequency) with a reasonable distribution in all the established sorts of abundance. They provided us according to their eurytope grade, with a plan of four large association groups which coincide with vegetation association groups in each community studied. Within these groups we could deduce the characteristic species by progressive elimination of the least eurytope and by comparison of their cenotic affinity and this enabled us to define the limits of synusial groups.
N.B. In this work we are considering only the fundamental species and their hierarchy.

COMPARISON OF THE FUNDAMENTAL SPECIES IN THREE COMMUNITIES

The following table shows the species that are considered fundamental in the three communities and those that are common to all.

	Pyrenees	Guadarrama	Tibidabo
Tullbergia krausbaueri (Börner)	+	+	+
Isotomiella minor (Schäffer)	+	+	+
Isotoma notabilis Schäffer	+	+	+
Folsomia quadrioculata (Tullb.)	+		+
Heteromurus major (Moniez)		+	+
Isotoma monochaeta Kos	+		
Lepidocyrtus lanuginosus (Gmelin)			+
Friesea nietoi Selga			+
Isotomina albaredai Selga			+
Onychiurus nemoratus Gisin			+
Onychiurus subparallatus Selga		+	
Onychiurus glebatus Gisin	+		

BIOCENOTIC HIERARCHY OF THE FUNDAMENTAL SPECIES

Pyrenees

I. Association groups in which *Folsomia quadrioculata* is constant
   1. Association groups in which *Isotomiella minor* is constant.
      a) Association groups in which *Onychiurus glebatus* is constant: Group A.
      b) Association groups in which *Onychiurus glebatus* is accessory or accidental: Group B.
   2. Association groups in which *Isotomiella minor* is accessory or accidental: Group C.

II. Association groups in which *Folsomia quadrioculata* is accessory or accidental: Group D.

Guadarrama

I. Association groups in which *Heteromurus major* is constant
   1. Association groups in which *Isotomiella minor* is constant
      a) Association groups in which *Isotoma notabilis* is constant: Group A.
      b) Association groups in which *Isotoma notabilis* is accessory or accidental: Group B.
   2. Association groups in which *Isotomiella minor* is accessory or accidental: Group C.

II. Association groups in which *Heteromurus major* is accessory or accidental: Group D.

Tibidabo

I. Association groups in which *Folsomia quadrioculata* is constant
   1. Association groups in which *Isotomiella minor* is constant
      a) Association groups in which *Heteromurus major* is constant: Group A.
      b) Association groups in which *Heteromurus major* is accessory or accidental: Group B.
   2. Association groups in which *Isotomiella minor* is accessory or accidental: Group C.

II. Association groups in which *Folsomia quadrioculata* is accessory or accidential: Group D.

A = Forest communities; B = Different forest communities; C = Open biotope communities; D = Communities of modified places.

Some fundamental species were exclused from this dichotomous hierarchy for the following reasons:

1. Wide dispersion and tolerance of biotic and abiotic factors, as in the case of *Tullbergia krausbaueri* in all three communities.
2. Altitude as a conditioning factor of their existence, as in the case of *Isotoma monochaeta* which is considered fundamental for the biocoenosis of the Pyrenees. This species had a high frequency and a fairly uniform distribution in all classes of established abundance, occupying a similar position to *Tullbergia krausbaueri* in altitudes of 1600 to 2400 m. If we limit the biocenosis of the Guadarrama Mountains to between 1300 and 2400 m above sea-level, *Isotoma monochaeta* is found as a basic species there. The species is not found in the biocenosis of Tibidabo Mountain (532 m above sea level).
3. Influence of temperature. Possibly the reduction of the average temperature excludes *Lepidocyrtus lanuginosus* as a basic species in the biocoenosis of the Pyrenees and the Guadarrama, biotopes in which it can be considered as dispersed. An increase in the mean temperature on Tibidabo gave rise to an increase of *Lepidocyrtus lanuginosus* in all its habitats, the frequency coefficient reaching 84 %.
4. Local regional indigenous influences resulting from environmental factors and the climax vegetation of the Mediterranean; this possibly accounts for *Isotomina albaredai* and *Friesea nietoi.* These influences are shown in the latter species by its wide distribution in coastal sclerophytic forests and by characteristics similar to those of southern species of the *Friesea* genus.
5. Specific ecological differentiation. This is true of *Onychiurus neglectus, O. glebatus* and *O. subparallatus,* which are different species from the group *Onychiurus armatus* s.l. (divided up by Gisin in 1952 but previously considered cosmopolitan and eurytope). This is a group which on being divided now shows itself to be a fine ecological indicator and here indicates a fundamental characteristic which distinguishes one biocenosis from another.

The following can be said of the significance of the species in the hierarchy of the three biocenoses:

Isotomiella minor is widespread and shows tolerance of all habitats consisting of tree or bush vegetation and a clear reduction in frequency and abundance in biotopes which could be termed open, such as meadows. This explains why *Isotomiella minor* shows the same group hierarchy in the three biocenoses, and this hierarchy is established in relation to phytosociology.

Folsomia quadrioculata which heads the dichotomous hierarchy of the biocenoses of the Pyrenees and Tibidabo shows a clear reduction in frequency and abundance only in samples of extreme habitats, for example, soils forming on rocks, modified meadows, etc. Its limited presence in the biocenosis of the Guadarrama cannot be for this reason and is more likely to be due to a factor of geographical distribution.

Heteromurus major, occupies an intermediate hierarchy in the biocenoses of Tibidabo and shows low frequency and abundance in the Pyrenees biocenoses.

Comparison of the cenotic coefficients of *Isotomiella minor, Folsomia quadrioculata* and *Isotoma notabilis,* two at a time, showed that these species had the same cenotic affinity in the biocenoses of the Pyrenees and Tibidabo as that already found by Cassagnau (1961) in the Central French Pyrenees and by Stach (1947) in the Tatra and Carpathian Mountains.

CONCLUSIONS

The high number of basic species in the biocenoses of Tibidabo was obtained from a selected area which is relatively homogenous in altitude. Some of the basic species are characteristic of Mediterranean biocenoses. The relationship of basic species in the Pyrenees biocenoses is characteristic of a type of Central European mountain. The reduction in the basic species in the Guadarrama biocenoses is mainly due to a wider range of altitude in the area sampled. The relationship of the species in the hierarchies clearly separates this biocenosis from those of the Pyrenees and Guadarrama. The relationships in Guadarrama may result from the same influences as the phytosociologists have found for the vegetation in the central mountains.

This study has made us aware that many Collembola which, when considered as species, would be classified as cosmopolitan and eurytope, show distinct ecological differences when we consider their distribution in their biotopes within a community. When their edaphic distribution in nature is considered they then appear in associations according to definite laws and whenever the same biotic and abiotic conditions are present in the environment they form similar associations.

However it is this very character of a cosmopolitan and eurytope species which allows them in most cases to head the hierarchy of the great asso-

ciations or supersynusia which can be seen in the part of the biotope studied. The finer structure of these associations, defined in terms of frequency, abundance and community relationships, coincides with vegetation associations.

REFERENCES

Agrell, I. 1941. Zur Ökologie der Collembolen. Untersuchungen im Schwedischen Lappland. Opuscula Entom., 3: 1-236.

Agrell, I. 1963. A sociological analysis of soil Collembola. Oikos, 14: 237-247.

Cassagnau, P. 1961. Ecologie du sol dans les Pyrénées centrales. Les biocenoses des Collemboles. Paris, Hermaun, 1-235

Cassagnau, P. 1965. Ecologie édaphique de las Montagne Noire basée sur les groupements de Collemboles.

Gisin, H. 1947.a) Analyses et synthéses biocénotiques. Archives des Sciences physiques et naturelles, 5: 42-75.

Gisin, H. 1947.b) Sur les Insects Aptérygotes du Parc national suisse. Espèces et groupements édaphiques. Res. reds. scr. Parc. nat. Suisse (N. F.) 2, 79-91.

Gisin, H. 1948. Etudes écologiques sur les Collemboles épigés. Mitteil. Schweiz. Entom. Ges. 21 (4): 485-515.

Selga, D. (at press) Estudio de los colémboles de la España Peninsular (Una introducción al conocimiento de los colémbolos como indicadores edáficos y biocenóticos).